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AUTHOR Williams, Kathleen; Turpin, Betty Ann M.
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ABSTRACT

The purpose of this study was to explore how children use location and distance cues to reproduce movements as compared with adults. Subjects were three groups of children, aged 6, 8, and 10, and one group of adults. A linear slide was used by the blindfolded subjects to indicate one of two experimenter-defined stops. Distance and location were tested on separate days. All subjects reproduced locations more accurately than distances, and adults were more accurate than children. Children seemed to use location information to reproduce movements, even when instructed to use distances. It was unexpected that no strong retention interval effect emerged. Subjects may have been cued inadvertantly to rehearse, resulting in performances that did not deteriorate following a retention interval. (Authors/FG)

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Age Differences in Short Term Memory: Retention of Location and Distance Cues

Kathleen Williams and Betty Ann M. Turpin, University of Wisconsin-Madison

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Age Differences in Short Term Memory: Retention of Location and Distance Cues

Kathleen Williams and Betty Ann M. Turpin, University of Wisconsin-Madison

Previous studies of age differences in short term memory for movement reproduction have had two major inadequacies. First, investigators have typically examined only the reproduction of locations. They apparently have assumed that children retain movement characteristics in the same manner as adults, who have been found to recall locations more accurately than distances. Second, most of the investigations with children have involved special populations (e.g., MRs, Blind, Autistic), while ignoring the performance of normal children. The purpose of this study was to alleviate these deficiences by investigating the reproduction and retention of distance and location information by normal children as compared with an adult control group.

In previous research, Kelso and his colleagues (1979) investigated reproduction of locations by mildly retarded children with mental ages between 6 and 9 years. They found that these children were more accurate when they had to reproduce a location immediately than when a 15 second retention interval intervened. No differential effect for age was found following either retention interval, suggesting that neither group of children was actively rehearsing.

Kelso and his colleagues (1979) tested their subjects using two movement lengths (short and long). Their children overshot both targets, regardless of age. They overshot the short target by more than the long target, however. Younger children overshot both targets to a greater degree than the older children did. These results differ from the "range effect" (Pepper & Herman, 1970) so typical of adult performances: On short movements, adults consistently overshoot and on long movements, they usually undershoot.

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A study by Hermelin and O'Connor (1975) was the only one in which both distance and location cues were investigated systematically in children. They tested blind, autistic, and blindfolded, normal children using vertical movements. They found that the blind and normal children, aged 10-15 years, could reliably and similarly reproduce locations, but not distances. Autistic children had larger errors than either of the other groups, but still reproduced locations more accurately than distances. In addition, errors for longer distances were greater than for farther locations for all children. Blind children undershot more than sighted children as distances increased, however.

To summarize, past investigations of age differences in short term memory for movement reproduction, have dealt primarily with special populations. These studies have examined how blind, autistic or retarded children used locations cues to reproduce simple movements. The purpose of this study was to extend these previous investigations by exploring how normal children use location and distance cues to reproduce movements.

Method

Subjects. Four groups of subjects (15 per group) were tested in this experiment. Children of 6 years ($\bar{X}$=73.6 months, σ=2.9), 8 years ($\bar{X}$=96.6 months, σ=2.6), and 10 years ($\bar{X}$=126.4 months, σ=3.5) and adults ($\bar{X}$=26 years, σ=3.8) participated. Permission was secured for all subjects or their parents prior to their participation. All subjects were volunteers.

Apparatus. A linear slide, similar to those used in other movement positioning studies, was used in this investigation. Subjects' performances could be measured to .1 cm accuracy. During testing, subjects were blindfolded and wore headsets. Low volume white noise, introduced through the headphones, excluded extraneous environmental noise. All directions

to the subjects were given through the earphones.

Procedures. Subjects were naive about the purpose of the study and were told only that it required making and remembering simple horizontal arm movements. Instructions were modified for age, where appropriate. The task required subjects to move a handle horizontally to one of two experimenter-defined stops while remembering either the movement's distance or the endpoint's location. Movements were 15 and 45 cm in length. Subjects tried to repeat the criterion movement from one of four different starting positions. They were tested on distance and locations conditions on separate days. Each session consisted of 32 randomized trials where half of the trials were reproduced immediately; half were reproduced 15 seconds after the criterion presentation. The order of administration of conditions was counterbalanced across subjects.

During the testing period, random praise was given for performance, regardless of the subject's true level of accuracy. No specific knowledge of results was given. All subjects, especially children, were reminded occasionally to concentrate on the task.

Results

For both constant and absolute errors, there were significant main effects for age ($F_{3,56}$=43.12 and 42.80, respectively, $p < .01$), mode (i.e., distance and location) ($F_{1,56}$=8.04 and 455.90, $p < .01$) and movement length (i.e., short or long) ($F_{1,56}$=78.09 and 18.68, $p < .01$). In addition, significant interactions were found between age and mode ($F_{3,56}$=67.65 and 46.29, $p < .01$), mode and movement length ($F_{1,56}$=11.98 and 44.98, $p < .01$), and retention interval and movement length ($F_{1,56}$=40.44 and 24.85, $p < .01$) for both dependent measures. For CE, the age X movement length ($F_{3,56}$= 5.87, $p < .01$) interaction also reached significance.

Post hoc Scheffe tests were performed on comparisons of interest. Figure 1 illustrates one of the interactions (age X mode), for AE. Clearly, all the children had larger errors than the adults for distance reproduction as compared to the location condition. The 6 year olds had larger errors compared to the 8 and 10 year olds for location reproduction. When age and movement length were compared, children had larger errors than adults for both short and long movements (Figure 2). Although all the children overshot short movements similarly, the 6 year olds overshot the long movements by less than the other children. All the children differed from the adults, who demonstrated a typical "range" effect.

One final analysis was suggested from observation of subjects' performances. Despite the care that was taken to make certain that children understood the task when they reproduced distances, they still appeared to be biased to reproduce locations. To test this notion formally, the data from the distance condition were transformed to equivalent location scores. These transformed scores than were compared with actual performances in the location condition. These analyses were non-significant for all the children, demonstrating that they always attempted to reproduce locations (Figure 3).

Discussion

The pattern of age differences found in this study was not as clearcut as might have been anticipated from the results of previous investigations. Although there was an overall significant effect for age, this was obviously attributable to better performances by adults, relative to all the children. Several interactions did help to clarify the occurrence of differences between the children, however. In general, these interactions suggested that the 6 year olds performed differently from the 8 and 10 year olds,

while the 8 and 10 year old children performed similarly. For example, all of the children performed similarly when distances were being reproduced. In contrast, 6 year olds were less accurate than the other children when locations were being reproduced (Figure 1).

While the finding of age differences at locations was anticipated, similar differences were expected for distance reproduction. It was surprising to find that all of the children seemed to use location cues when reproducing all movements. Informal observation had suggested that the 6 year olds (and possibly some 8 year olds) had performed in this manner. It was not anticipated that the 10 year olds would also use only locations, however.

The exact reason for these results was unclear. Care was taken to ensure that subjects understood the distinction between distance and location prior to the initiation of testing. Before testing could begin, subjects had to be judged to have a cognitive understanding of the distance concept. It seemed that the children failed to translate their apparent knowledge of "distances" into use in the actual reproduction of their movements.

The use of two different movement reproduction lengths resulted in additional age differences (Figure 2). Consistent with previous findings by Kelso and his colleagues (1979), the children overshot short movements by more than long movements. Contrary to Kelso's study, our children performed similarly on short movements, while younger children overshot less than older children for long movements. Hermelin and O'Connor (1975) found a similar phenomenon with their blind and autistic children as vertical heights increased. They suggested that blind children may have difficulty in reaching outside their immediate body space. Young children in this study may have demonstrated a similar limitation. Warren (1974) suggested that there are two separate systems for remembering movements: One operating

within the immediate body space, the other for movements outside that immediate sphere. Perhaps developmentally young subjects learn to use the inner space first; accurate movements in the outer sphere may occur later.

An unexpected finding in this investigation was the lack of a strong influence for retention interval. Two previous investigations, involving either adults (Laabs, 1973) or children (Kelso et al, 1979) found significant retention interval effects. In these previous studies, however, the influence was demonstrated by increased variability over the retention interval. Variable errors (VE) were not analyzed in this study (Safrit, Spray, & Diewert, 1980).

Kelso et al (1979) also found a main effect for retention interval in their AE analysis. In this investigation, retention interval just failed to reach significance at the .01 level. Even these results were puzzling, particularly since adults were included in this design.

This unexpected pattern of results may have occurred due to a procedural emphasis. Wickens (1974) and others (e.g., Sroufe, 1971) have suggested that some of the age differences found in studies are attributable to differences in the attentional level of subjects. Young children are not as motivated to stay on task, and subsequently perform more poorly than their older peers and adults. Pilot testing had suggested that younger children would have difficulty remaining on task, particularly over a 15 second retention interval. Therefore, in this study, subjects were occasionally reminded to stay on task. In an effort to account for the relatively higher level of inattention by younger children, they were cued more often than older children and adults.

This effort to keep children on task seemed to have led to an inadvertent result: Rehearsal by the children. Although young children usually do

not spontaneously rehearse, they can be induced to do so on specific tasks (Appel, Cooper, McCarrell, Sims-Knight, Yussen, & Flavell, 1972; Flavell, Beach & Chinsky, 1966). Therefore, by giving these children cues in an attempt to maintain their attention to the task, it is likely that we helped them to rehearse the information. This additional cue may have eliminated the usual increase in errors found for young children who are asked to retain information over a retention interval.

In summary, there were differences and similarities in the results of this investigation compared to previous studies of short term memory for movement reproduction. First, all subjects reproduced locations more accurately than distances and adults were more accurate than children overall. Children apparently always used location information to reproduce movements, even when instructed to use distances. While children overshot both movement lengths, as previous investigations had found, the youngest children overshot short movements less than others. That finding was contrary to the results of at least one other study. Finally, it was surprising that no strong retention interval effect emerged. Subjects may have been cued inadvertently to rehearse, resulting in performances that did not deteriorate (as expected) following a retention interval.

NOTE

This paper was presented to the Research Consortium at an annual meeting of the American Alliance for Health, Physical Education, Recreation, and Dance, Houston, TX, April, 1982.

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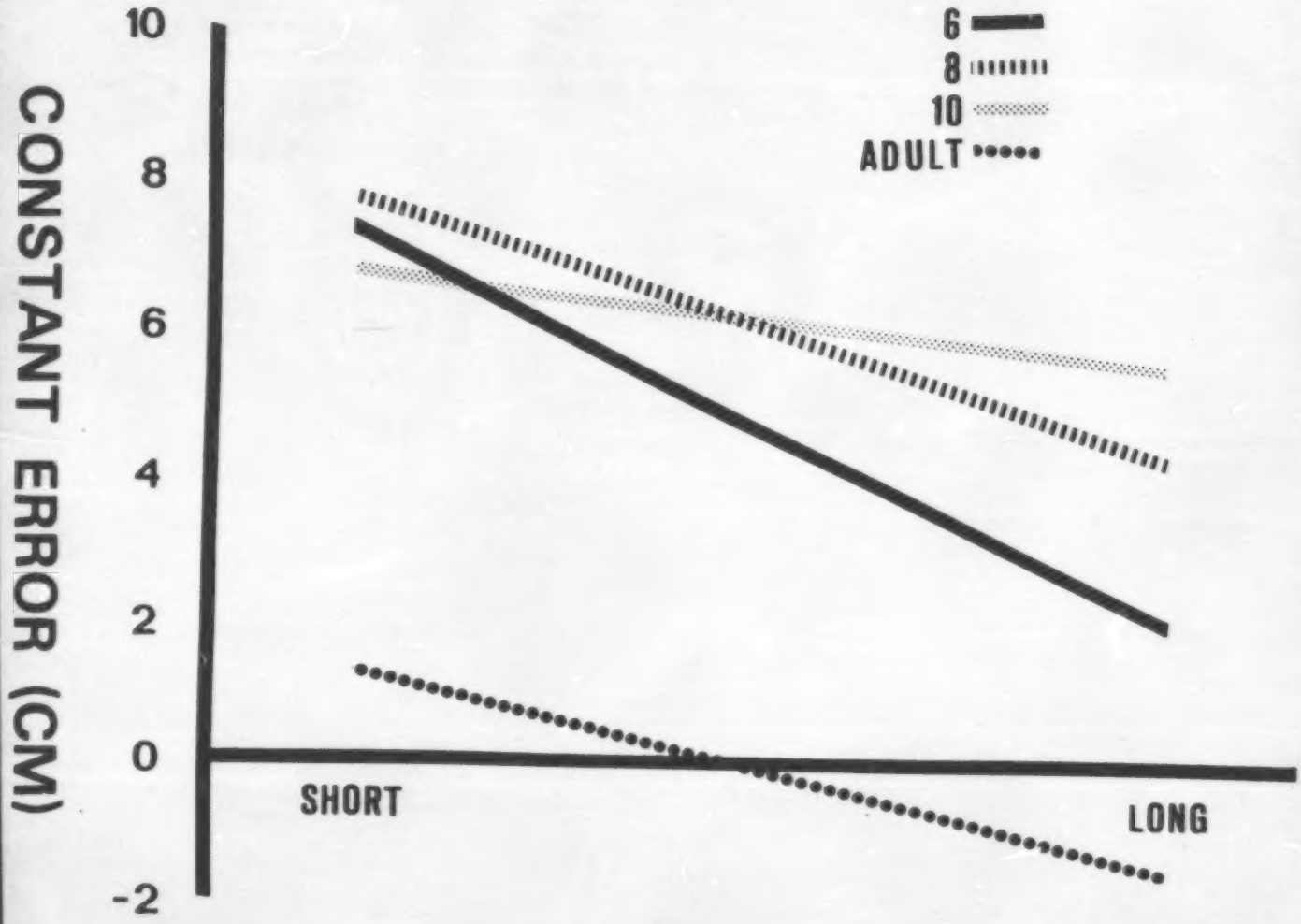
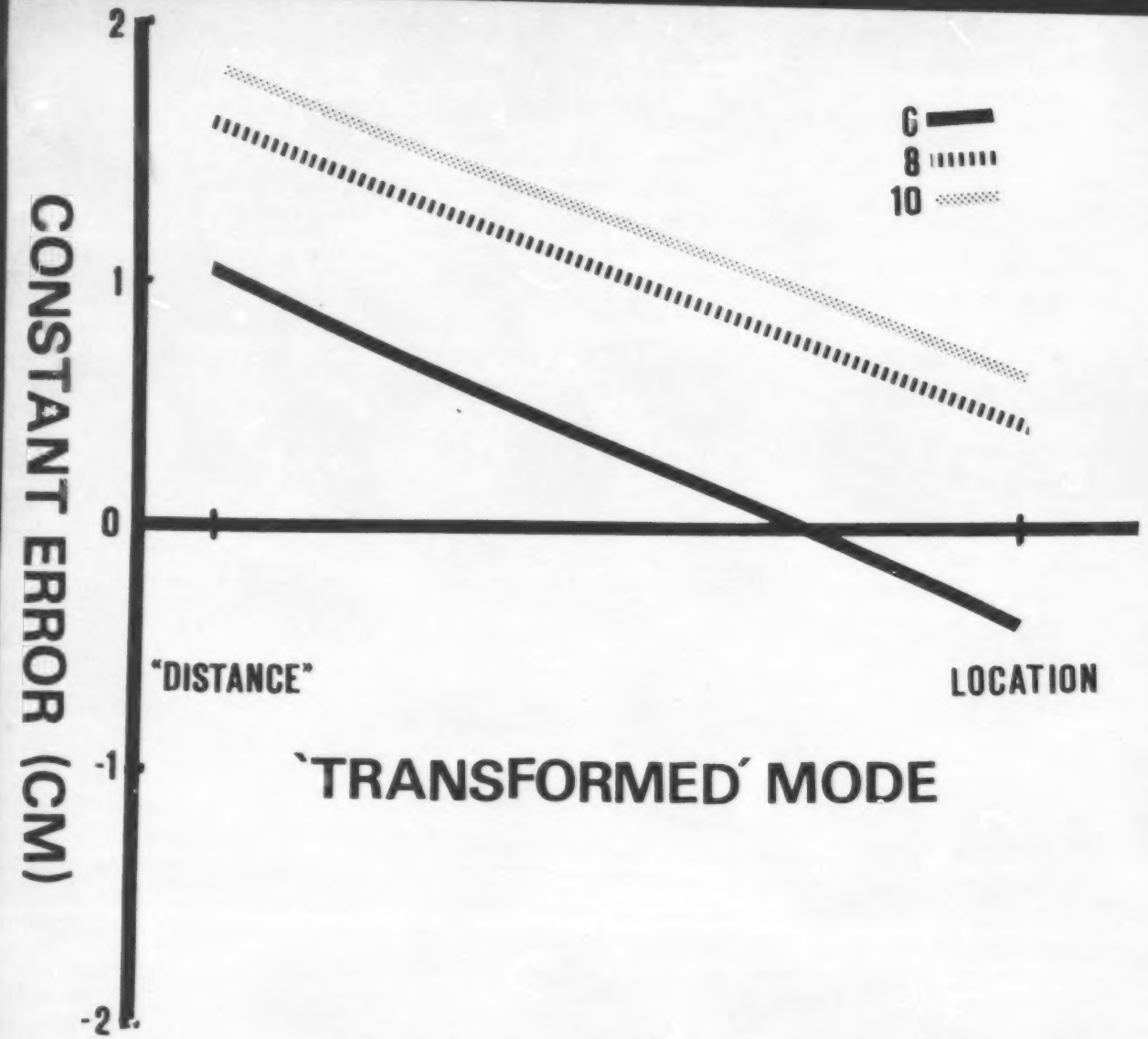
FIGURE CAPTIONS

Figure 1. Age differences for children and adults in the magnitude of absolute errors for distance and location conditions.

Figure 2. Age differences in constant errors for short and long movement lengths.

Figure 3. Age differences for children in constant errors for transformed distance and location conditions. Distance condition errors have been transformed to equivalent location error scores.


10
8
6
4
2
0
-2
CONSTANT ERROR (CM)
6
8
10
ADULT
SHORT
LONG
MOVEMENT LENGTH



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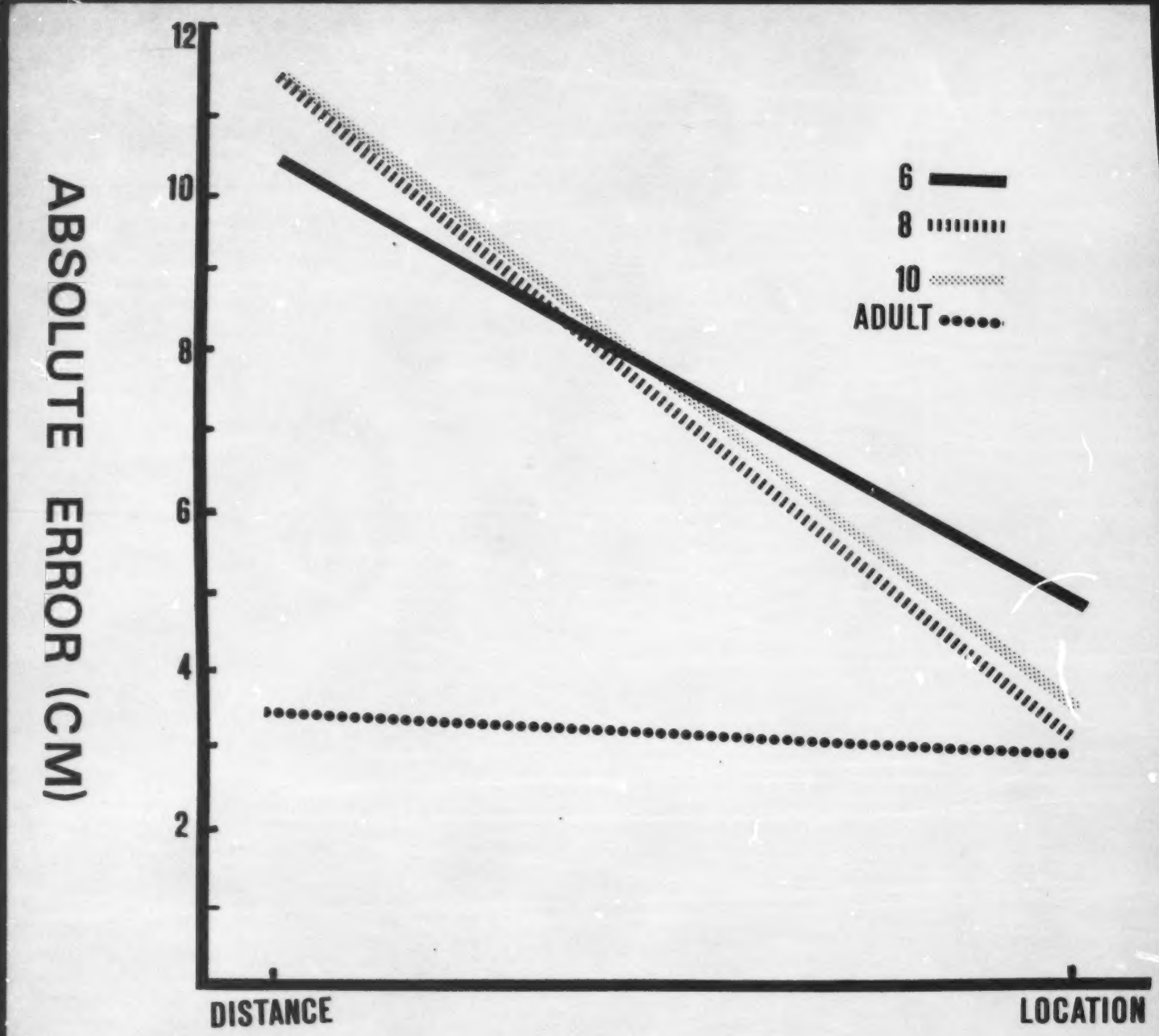
ABSOLUTE ERROR (CM)
12
10
8
6
4
2
6
8
10
ADULT
DISTANCE
LOCATION
MODE